The Things We Care to See: The Effects of Rotated Protocol Immersion on the Emergence of Early Observing Responses

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Abstract

We tested the effect of a Rotated Protocol Immersion package on the emergence of observing responses as prerequisites for more complex verbal developmental capabilities. Three elementary aged students between the ages of 6 and 7 participated. They were diagnosed with autism spectrum disabilities. The treatment condition consisted of total immersion in a rotation of six pre-listener Protocols (Greer & Ross, 2008), designed to induce foundations for verbal developmental capabilities. The participants were selected for their demonstrated lack of early observing responses (Keohane, Delgado & Greer, in press). They did not respond when their names were called, orient toward voices in the environment, or follow instructions. They did not seek out the attention of others unless it was to fill an immediate need. The dependent variables in the study were observing responses; learn units to criterion, instructional objectives met, and incidental performances across instructional and non-instructional settings. We used a time-lagged multiple probe design and found significant increases in the dependent variables. Additionally, the post-probes demonstrated a range of increases in the number and level of complexity of students' observing responses. The results are discussed in terms of theoretical implications, as well as, in the context of behavioral research on child development, and the hierarchy of verbal developmental capabilities.
Keywords: Development, verbal developmental capabilities, behavioral developmental cusps, learn units, observing responses, developmental delays, verbal behavior.

As organisms living in a complex environment we are affected by multiple stimuli from moment-to-moment. As a result we have developed a singularly efficient method of selecting and attending to stimuli so that we can affect some kind of control over the environment in which we live. For some of us, observing is the foundation of our entire system of scientific inquiry (Haury, 2002). For most of us, observing connects the physical world, the sensory information we receive from it, and the uniting of those discriminations as we interpret that information.

Observing responses are operant responses that are selected out by their consequences. These responses can be measured in terms of their sensory modalities. When a child looks at a person calling his name, listens to someone giving a direction, tastes foods, smells a flower, or touches items across a variety of textures, the child is responding as an observer of the environment. The various stimuli that reinforce those responses provide a conditioning process for observing (Keohane, Delgado & Greer, in press). Importantly, observing responses and the reinforcers that support them are basic to the emergence of increasingly more complex behaviors (Donahoe & Palmer, 2004; Greer & Ross, 2008). As part of our search for more effective ways to provide instruction to children with disabilities so that they would have increased access to the social community, we became increasingly aware of the role of observing responses and their controlling stimuli.

Observing has been a topic of interest to many fields of inquiry. Psychology in particular has attempted to understand observing behavior. Over time, psychology has branched into a myriad of sub disciplines, each providing explanations of a variety of interests from divergent perspectives. With the

specialization of sub disciplines, individuals have found it necessary to define the terms they use to talk about phenomena. How we define terms has far reaching effects for their application in research. As each sub discipline separated from the others, they often distinguished themselves by insisting on their own definitions and terms. Behaviorism did just that. Skinner proposed distinct vocabulary for use in talking about language and differentiated it from the terminology used by other types of psychologists (Skinner, 1957).

From a behavioral perspective, language and the study of language, has been greatly influenced by Skinner's proposition of a functional account of language. Observing is a critical element of language function and is treated in Skinner's account of language. Skinner referred to "observing behavior," and suggested that there may be some "automatically reinforcing properties" of observing behavior, when it functions to intensify or bring into focus the stimulus discriminative (p. 416). Donahoe and Palmer (2004) defined observing responses as: "acquired environment-behavior relations whose primary function is to affect the sensing of stimuli (p. 156)." Essentially, our ability to have salient environmental stimuli select our observing responses is adaptive and provides us with the controls of what we experience in our world.

We believe that observing responses represent the first instances of the joining of the listener and speaker repertoires, as defined by Skinner. As such, the joining provides an intersection of what are at first two distinct repertoires. We argue that joint control provides the first evidence of truly complex operant responding, particularly as it relates to the development of language. Observing appears to be critical to the foundation of the acquisition of language (Greer & Keohane, 2005; Keohane, Pereira Delgado, & Greer, in press) and as such, represents a valuable focus for research and inquiry.

Conceptually, observing responses, as we have defined them, can be compared to establishing operations or, perhaps even more so, to a setting factor in the physical sense (Bijou, 1996). Bijou defines the type of setting factor related to physical circumstances as having an effect on the apprehension of the antecedent stimuli for the organism. The difference in the definition of observing is that the locus of control appears to be with the environment when looking at a setting factor, and, with observing responses, the locus of control appears to be the organism.

At this point in the analysis, developmental psychology may provide a potential model for discussion, by defining changes in complexity of observational responses in the context of the organism over time. Traditional explanations of developmental stages have placed emphasis on the fixed measures of age/maturity of the organism (Bijou, 1996). This conceptualization is less useful to applied researchers, however, as a matter of practicality. We have yet to find the means to accelerate or decelerate time and our fieldwork abounds with examples of individuals who fail to conform to fixed measures of development. Instead, behavior analysts have proposed the idea of behavioral developmental cusps (Bijou, 1996). Rosales-Ruiz and Baer define cusps as a time when an individual's growth, or development, places it in a unique position to access new contingencies in the environment that it could not previously access. They suggest that cusps may be differently defined for different individuals. This conception is useful to applied researchers because it allows us to ask the question: can we *create* a cusp by manipulating the contingencies in the environment?

Our research has already taught us that, indeed, there are many other things that can be manipulated. Repeatedly, manipulation of establishing operations has been most remarkably demonstrated to be an effective method of inducing first instances of language (Greer, & Ross, 2008; Ross & Greer, 2003; Tsiouri & Greer, 2003). Observing, as a behavioral phenomenon, can be considered a by-product of the conceptual phenomenon of behavioral developmental cusps, and is, certainly, tightly bound to the conceptual phenomenon of establishing operations. If a child has not achieved naming (Fiorile, & Greer, 2006; Gilic, 2005; Greer, Stolfi & Pistoljevic, 2007; Horne, & Lowe, 1996; Horne, Lowe, & Randle, 2004) and doesn't know what lemonade is, and didn't observe the lemonade in the

pitcher, it is unlikely that she will mand for a glass of lemonade—no matter how thirsty. We can teach the child to mand for lemonade but, unless she comes under the control of the establishing operation and unless she can control her observing responses so that she can use them to her advantage, there is little functionality to the instruction.

Verbal developmental capabilities serve as a subset of behavioral developmental cusps, specifically focused on the verbal behavior of human organisms. When an individual is able to learn something that he or she could not learn before, and able to acquire new repertoires that were previously inaccessible, they are considered to have achieved a new capability (Greer, & Ross, 2008). Verbal developmental capabilities are informed by the functional account of language provided by Skinner (1957), and are conceptualized in a hierarchical fashion, with more complex capabilities at the top of the pyramidal structure, supported by a broad base of more basic capabilities that, while separated from one another initially, come together in combinations under joint control to form more complex capabilities.

Within the concept of the hierarchical structure of verbal developmental capabilities, there are five prerequisite early observing capabilities. These are considered foundational capabilities to the development of complex language. They include: conditioned reinforcement for faces, adult voices, and 3D and 2D stimuli, as well as the basic capacity for sameness across the senses. Additionally, generalized imitation is conceptualized as a co-requisite of these early capabilities. We consider all six capabilities to be essential to the development and eventual synthesis of listener and speaker capabilities, and the formation of higher order operants, required for an individual's full inclusion in the verbal community. We used the data and experiential information we have thus far acquired from fieldwork to suggest and inform additional directions for study. Our applied work has provided us with a research-based platform from which to define and measure changes in responding that we have observed in our students.

The focus of this study was to investigate the effects of implementing the Rotated Protocol Immersion procedure as a means of inducing new verbal developmental capabilities for three students, and the emergence of observing responses associated with novel social responses, accelerated rates of learning across instructional programs, and decreases in maladaptive responses across environments. We elected to rotate all of what we have identified as early observing protocols in order to test the efficiency of such a treatment package. We believe these observing responses are foundational to all that a child must learn. We proposed the following questions to test our theory: Can we create conditions in which early observing responses can emerge? What changes will we see in our students as a result? And how quickly can we do it?

Method

Participants

The participants in this study were three elementary aged students, two males and one female, ranging in age from six to seven years old. All three were diagnosed with autism spectrum disabilities. All students demonstrated low levels of observing responses in at least three areas, as defined within our study.

All three participants attended a self-contained special education classroom in a public elementary school for general education students. The classroom had an 8:1:2 students to teacher, teaching assistants ratio. See Table 1 for a complete description of the participants including a list of their verbal capabilities at the outset of the study. It should be noted that all students were under a teacher's instructional control at the outset (Greer & Ross, 2008).

Table 1

Participant Characteristics

Dan	Eric	Fran
Male **CA: 6 years** **Diagnosis: ASD**	**Male** **CA: 7 years** **Diagnosis: ASD**	**Female** **CA: 7 years** **Diagnosis: ASD**
Emergent reader/writer; Limited listener/speaker	**Early speaker/ listener**	**Early speaker/ listener**

Setting

The participants attended a district-based program situated in a public elementary school, providing services for typically developing children and children with developmental disabilities. The school was located in a suburban area, outside a major metropolitan city and employed the Comprehensive Application of Behavior Analysis to Schooling (CABAS®) (Greer, Keohane & Healy, 2002; Lamm & Greer, 1991; Selinski, Greer, & Lodhi, 1991). .The classroom provided educational services for children between the ages of five and eight, ranging from Kindergarten through third grade. The classroom ratio of students to teachers was 8:1:2. Students were assessed according to the New York State Curricula Standards, the Preschool Inventory of Repertoires for Kindergarten (Greer & McCorkle, 2003) and the Verbal Capabilities Checklist (Greer, & Ross, 2008). Instructional objectives were selected based on these assessments as well as each student's IEP goals.

The study took place in several locations across the school environment and the classroom. Probe sessions were conducted outside on the playground, and inside the classroom in free-play areas, individual, and group instructional areas. Protocol instruction was conducted in the classroom at a child-sized desk near the teacher's desk, with two chairs—one for the instructor and one for the student.

Dependent Variables

The target behaviors in this study consisted of 15 measures that included recording responses as intervals, duration, frequency, trials and learn units (Greer, 2002). The frequency with which the participant engaged in appropriate verbal behavior such as mands, tacts, sequelics, or conversational units or engaged in non-functional self-talk was observed. Whole interval and partial interval recordings were used for these. A frequency count was conducted for appropriate language interactions. All the categories were measured in pre- and post-probes across the following three settings: free-play (either in the classroom or the playground), structured individual instruction, and structured small group instruction.

Eye contact with other individuals was measured in all three settings (free-play, 1:1, group). These measures were calculated as mean and total duration of seconds across 20 opportunities. The learn units to criteria were calculated for all instructional programs. The number of correct responses in 20 opportunities was recorded for generalized imitation, incidental following directions, responding to name, incidental auditory observations, and incidental visual observations, for a total of 100 opportunities. See Table 2 for a table of dependent variables as per each measurement procedure.

Table 2

Dependent Variables as Per Each Measurement Procedure

Number of Five -Second Intervals in Five Minute Period or Frequency Count	Mean and Total Duration Measures in Seconds for 20 Trials	Number of Learn Units	Number of Responses Out of 20 Opportunities
Non-functional self-talk (partial interval) across three settings (free, 1:1, group)	Duration of eye contact in three settings (1:1, small group, and unstructured)	Total learn units to criterion for instructional programs	Generalized imitation
Appropriate verbal behavior (echoics, mands, tacts, sequelics, conversational units)across three settings (free, 1:1, group)			Incidental following directions
			Respond to name
			Observing responses associated with auditory modalities (Incidental observing responses)
			Observing responses associated with visual modalities (Incidental observing responses)

Rotated Protocol Immersion

The independent variable in this study was the rotation of a package of six pre-listener protocols. The six protocols were research based and designed to induce early observing responses in children who did not already demonstrate them and were identified in prior work (Greer, & Ross, 2008). The rotated protocols used in this study were: Conditioned Reinforcement for Observing Faces Protocol (Keohane, Greer, & Lewis, 2008); Conditioning Reinforcement for Listening to Adult Voices Protocol (Greer & Keohane, 2005; Greer, Keohane, Ackerman, Kang & Walsh, 2006; Greer, Keohane & Delgado, 2006; Keohane, Greer, Nuzzolo, Kang, Solow, Bayard, Reilly & Walsh, 2006; Keohane & Pereira Delgado, in press); Visual Tracking Protocol for Conditioning Sustained Eye Contact of 3-D Visual Stimuli (Greer & Keohane, 2005; Greer, Keohane, O'Sullivan & DeMarco, 2006; Keohane, Greer & Ackerman, 2005; Keohane, Greer, Ackerman, Delgado, Weigand, DeMarco & Zrinzo, 2006; Keohane & Pereira Delgado, in press); Visual Tracking Protocol for Conditioning Sustained Eye Contact of 2D Print Stimuli (Greer, Pereira Delgado, Keohane, Speckman-Collins, & Goswami, 2006); Sensory Matching Protocol for Matching Across the Senses (Greer & Keohane, 2005; Greer, Keohane, Ackerman, O'Sullivan, Park, Longano, Kracher & Wiehe, 2006; Keohane, Greer & Ackerman, 2005); and Acquisition of Generalized Imitation Through the Mirror Protocol (Greer & Keohane, 2005; Keohane, Pereira Delgado, & Greer, in press). Please see Greer and Ross (2008) and Keohane, Pereira Delgado, and Greer (in press) for a full description of the procedures for implementing each protocol.

Protocols were implemented with a single student at a time, who worked with a single adult instructor. All instructional programs were suspended during Rotated Protocol Immersion. However, each student continued to participate in large and small group activities, play area free-play, music, art, gym, inclusive lunch and outdoor play time, and classroom activity time with general education students, Each protocol was conducted for one complete session (20-25 trials as specific to each protocol) before moving

on to the next protocol. Protocols were conducted in the following order: Conditioned Reinforcement for Faces Protocol, Conditioning Listening to Adult Voices Protocol, Visual Tracking Protocol—3-D stimuli, Visual Tracking Protocol—2D print stimuli, Sensory Matching Protocol, and Mirror Protocol (See Figure 1). When a student met criterion on a single protocol, that protocol was removed from the rotation. The remaining protocols were continued until the student met criterion on all six protocols. There was one notable exception to this procedure. Dan continued instruction in each protocol until criterion had been met for all six protocols (mastered protocols were not removed from rotation for Dan).

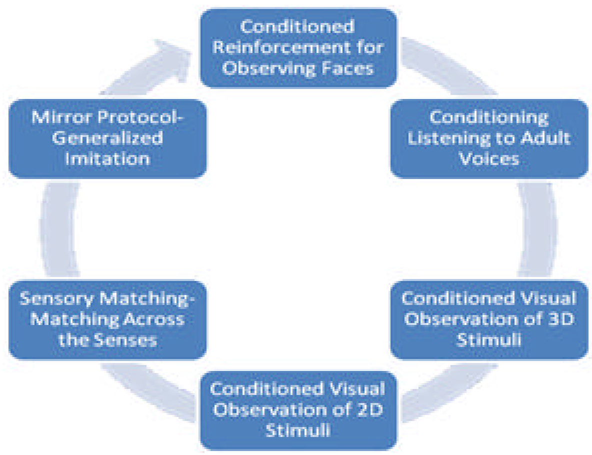

Figure 1. Rotated protocol immersion

Data Collection

Pre- and Post-Probe Sessions of Incidental Observing Responses: During probe sessions, data were collected using a pen, data collection sheet, clipboard, and timer by one or two observers. Timers were used to ensure accuracy of interval recordings. Partial interval recordings were scored if the student emitted at least one instance of the targeted behavior. Whole interval recordings required the student to emit the targeted behavior for the duration of the five-second interval. Frequency counts of targeted behaviors were tallied and graphed out of opportunities, learn units, or trials. Duration measures were calculated using a timer to measure seconds. Total seconds were rounded to the nearest whole number; mean measures were rounded to the nearest tenth of a second.

Pre- and Post-Probes of Responses to Instruction

Rotated Protocol Immersion: Data were collected during instructional sessions using a data collection form, a pen, and a timer. Learn units were presented during Sensory Matching and the Mirror Protocol. Correct and incorrect responses to learn units were recorded. The Sensory Matching procedure consisted of presentation of 25 learn units in a single session. The Mirror Protocol consisted of presentation of 20 learn units in a single session. A pair-test trial procedure was used for Conditioning Faces, Conditioning Adult voices, Conditioning 3-D Visual Stimuli, and Conditioning 2D Print Stimuli. Correct and incorrect test trials were recorded and a timer was used to count total number of seconds

engaged in targeted behavior for each trial. Data were recorded and graphed as the numbers of correct responses to learn units or the number of total seconds engaged in the target behavior. Graphical displays of the data were available for visual inspection on a daily basis.

Procedure

Both pre- and post-experimental probes were conducted with all three participants. After pre-probes had been completed for an individual student, regular instruction was suspended, and the student was exposed to rotated protocol immersion across his/her academic day. The student continued to participate in the social routine of the school day and was included in lunch, recess, and therapeutic services (speech, physical therapy, and occupational therapy), as well as class wide enrichment services such as adapted physical education, art, and music. Group activities that included listening to stories, free play, class games, and morning and afternoon whole group activities, were continued as well. When the student met criterion on the protocols, she/he returned to pre-protocol instructional goals as based on the student's long-term PIRK and NYS standards objectives. Therefore, post-protocol probes for instructional responding were based on the student's responses to long-term objectives so that significant changes in academic performance could be clearly measured. Students received 1000 learn units prior to the conducting of post-probes. Once the first student completed rotated protocol immersion and reached criterion for the protocols, the second student began the rotated protocol immersion process. Students took from five to ten days to complete rotated protocol immersion.

Interobserver Agreement

Interobserver agreement was collected for 85% of all pre- and post-probes. Agreement ranged from 92%-100%, with a mean of 94%. Additionally, Interobserver agreement was collected using the Teacher Performance Rate Accuracy (TPRA) observations (Ingham & Greer, 1992) during rotated protocol immersion as measures of the accuracy of treatment. TPRA accuracy scores ranged in agreement from 90%-100%, with a mean agreement of 98%. Interobserver agreement was obtained for measures of incidental responses and learn unit to criterion measures. Interobserver agreement was 100%.

Design

A time-lagged, multiple probe design across participants was used for this study (Johnston & Pennypacker, 1993). When the first student completed Rotated Protocol Immersion, to criterion, the second student began the immersion. When the second student achieved mastery criteria, the third student began the process. Post-probes were completed for each student immediately following criterion levels of responding. Baseline probes were conducted for each participant prior to the onset of rotated protocol immersion. Once a participant met criterion on the rotated protocol immersion they returned to regular instruction. When 1000 learn units of regular instruction were completed, post-probes were conducted on all 15 dependent measures.

Results

Dan completed four of the six protocols in rotated protocol immersion. He required 6-sessions to meet criterion on Conditioned Reinforcement for Looking at Faces. Pre-probes demonstrated that he already had conditioning reinforcement for listening to adult voices and generalized imitation in his repertoire. As a result the protocol for Conditioned Reinforcement for Adult Voices and the Mirror Protocol for Generalized Imitation were not included in the rotation. He required 8 sessions to meet criterion for Visual Tracking of 3D stimuli, 5 sessions to meet criterion for Visual Tracking of 2D stimuli, and 4 sessions to meet criterion for Sensory Matching.

For Dan, learn units to criterion across all regular instructional programs decreased from 250 to 174. Sustained eye contact in a group setting went from 0 seconds to a total of 22 seconds across 20

opportunities. In the free-play setting, sustained eye contact increased from 5 to 16 seconds, and in the 1:1 instructional setting, sustained eye contact increased from 12 to 46 total seconds. Dan's sustained eye contact with people or objects increased in all three settings after the rotated protocol immersion. Pre- and post-probe data were measured in interval recordings across three settings. Pre-probe data showed that Dan was engaged appropriately in 29 out of 60 intervals during measurement of 5-second intervals in the group setting, 0 intervals in the free-play setting, and 29 intervals in the 1:1 setting. Post-probe data showed that Dan was engaged appropriately in 30 intervals in the group setting, 35 intervals in the free setting, and 31 intervals in the 1:1 setting out of 60 possible intervals. The data demonstrated that Dan was significantly more engaged in the free-play setting after the rotated protocol immersion. During pre-probes Dan engaged in non-functional self-talk during group in 4 intervals, during free-play in 40 intervals, and during 2 intervals in the 1:1 setting. Post-probe data show that Dan engaged in non-functional self-talk in group for 6 intervals, in free-play for 7 intervals, and in the 1:1 setting for 4 intervals. A significant change was noted in the free-play setting, wherein Dan emitted non-functional self-talk in far fewer intervals after rotated protocol immersion. Dan's appropriate verbal behavior decreased in both the group and free-play settings (13 to 0, 11 to 9, respectively) but increased significantly in the 1:1 setting, increasing from 4 instances to 40 instances after completion of rotated protocol immersion. The changes in Dan's performance across opportunities to respond, as measured in pre- and post-probe data, were as follows: generalized imitation increased from 16 to 19 correct responses, respond to name from 12 to 15 correct responses, incidental following directions from 8 to 17 correct responses, incidental auditory observations from 0 to 12 occurrences, and incidental visual observations from 4 to 16 correct responses. Dan's observing of objects in a tabletop setting increased between pre- and post-probe measures and observation of 2D visual stimuli increased from 107 total seconds to 183 total seconds across 20 consecutive trials, and observations of 3D visual stimuli increased from 124 total seconds to 146 total seconds after completion of rotated protocol immersion. The post-probe data show that Dan's observing responses increased, as did his learning objectives after the completion of the rotated protocol immersion.

Eric completed all six protocols. Protocols were removed from the rotation once mastered; keeping only unmastered protocols in rotation until all six protocols were mastered. Eric required 6 sessions to meet criterion on Conditioned Reinforcement for Looking at Faces. He required 7 sessions to meet criterion for Conditioning Listening to Adult Voices and 5 sessions to meet criterion for the Mirror Protocol for Generalized Imitation. Eric required 6 sessions to meet criterion for Visual Tracking of 3D stimuli, 5 sessions to meet criterion for Visual Tracking of 2D stimuli, and 9 sessions to meet criterion for Sensory Matching.

For Eric, learn units to criterion across all regular instructional programs decreased from 345 to 200. Sustained eye contact in a group setting decreased from 5 seconds to 21 seconds total across 20 opportunities. In the free-play setting, sustained eye contact increased from 0 to 7 seconds, and in the 1:1 instructional setting, sustained eye contact went from 10 to 152 total seconds. Eric's sustained eye contact with people or objects increased across all three settings after rotated protocol immersion, but changed most significantly in the 1:1 setting. During pre-probe interval recordings across three settings, Eric was engaged appropriately in 16 intervals of 60 possible 5-second intervals in the group setting, 3 intervals in the free-play setting, and 20 intervals in the 1:1 setting. Post-probe data showed that Eric was engaged appropriately in 21 intervals in the group setting, 19 intervals in the free-play setting, and 27 intervals in the 1:1 setting. Eric's data show increased responding in all settings after rotated protocol immersion, with the most significant increase in responses recorded during the free-play setting. Eric engaged in non-functional self-talk during group in 0 intervals during pre-probes, during free-play time in 6 intervals during pre-probes, and during 1:1 in 13 intervals during pre-probes. Post-probe data show that Eric engaged in non-functional self-talk in group for 0 intervals, in free-play time for 19 intervals, and in 1:1 instruction for 1 interval. Eric's non-functional self-talk after rotated protocol immersion, increased in the free-play setting and decreased in 1:1 instruction. Eric's appropriate verbal behavior did not change

significantly in either the group or free-play settings (1 to 0, 1 to 1, respectively) but a significant increase was noted in the 1:1 setting, increasing from 5 instances to 16 instances after completion of rotated protocol immersion. Eric's data indicate changes in performance across opportunities to respond, as measured in pre- and post-probes as follows: generalized imitation increased from 8 to 18 correct responses, respond to name from 6 to 13, incidental auditory observations from 0 to 2 occurrences, and incidental visual observations from 1 to 4 correct responses. The data show little change for incidentally following directions with responses decreasing from 11 to 10. Eric's eye contact of objects in a tabletop setting changed from pre- and post-measures: observation of 2D stimuli increased from 131 total seconds to 187 total seconds across 20 consecutive trials, and observations of 3D stimuli increased from 31 total seconds to 132 total seconds. The post-probe data demonstrate significant increases in learning and observing responses for Eric after the completion of the rotated protocol immersion.

Fran completed four of the six protocols in rotated protocol immersion. When Fran achieved mastery of a specific protocol, that protocol was removed from rotation. The remaining protocols were continued in the same order as initially presented, minus the mastered protocols, until all protocols had been mastered. Fran required 3 sessions to meet criterion on Conditioning Listening to Adult voices. Pre-probes demonstrated that looking at faces was already a conditioned reinforcer for Fran, and that she had generalized imitation in her repertoire. As a result the protocol for Conditioned Reinforcement for Looking at Faces and the Mirror Protocol for Generalized Imitation were not included in the rotation. Fran required 4 sessions to meet criterion for Visual Tracking of 3D stimuli, 7 sessions to meet criterion for Visual Tracking of 2D stimuli, and 9 sessions to meet criterion for Sensory Matching.

For Fran**,** learn units to criterion across all regular instructional programs decreased from 500 to 326. Sustained eye contact in a group setting increased from 28 seconds to 49 seconds across 20 opportunities. In the free-play setting, sustained eye contact increased from 3 to 47 seconds, and in the 1:1 instructional setting, sustained eye contact increased from 14 to 75 seconds. Fran's sustained eye contact with people or objects increased in all three settings after rotated protocol immersion. During pre-probes of interval recordings across three settings, Fran was engaged appropriately in 3 intervals of 60 possible 5-second intervals in the group setting, 0 intervals in the free-play setting, and 2 intervals in the 1:1 setting. Post-probe data showed that Fran was engaged appropriately in 38 intervals in the group setting, 4 intervals in the free-play setting, and 24 intervals in the 1:1 setting. Fran was significantly more engaged in group and 1:1 settings after rotated protocol immersion. Pre-probe data showed that Fran engaged in non-functional self-talk during group in 33 intervals, during free-play time in 55 intervals, and during 1:1 in 49 intervals. Post-probe data show that Fran engaged in non-functional self-talk in group for 8 intervals, in free-time time for 41 intervals, and in 1:1 for 26 intervals. Fran's non-functional self-talk decreased across all three settings, most significantly in the group setting. Fran's appropriate verbal behavior increased across all three settings ranging from 0 to 18 instances in group, 1 to 8 instances in free-play, and 5 to 11 instances during 1:1 instruction. Fran's appropriate verbal behavior was positively affected by completion of rotated protocol immersion. Fran's changes in performance across opportunities to respond, as measured in pre- and post-probe data, were as follows: generalized imitation increased from 4 to 18 correct responses, respond to name increased from 9 to 10, incidental following directions increased from 2 to 14 correct responses, incidental auditory observations increased from 1 to 2, and incidental visual observations increased from 5 to 8 correct responses. Fran's eye contact of objects in a tabletop setting increased between pre- and post-probe measures: observation of 2D objects from 34 total seconds to 203 total seconds across 20 consecutive trials, and observations of 3D objects from 65 total seconds to 178 total seconds. The post-probe data demonstrate significant increases in learning and observing responses for Fran after the completion of the rotated protocol immersion.

Results are displayed in Figures 2-6 below. Figure 2 shows the cumulative number of seconds that each participant made eye contact across the three measured settings: group, free-play, and 1:1 instruction, in a total of 60 opportunities. Measures are presented from both pre- and post-probes. Each of

the three participants emitted significantly higher levels of eye contact after rotated protocol immersion. Figure 3 shows the cumulative number of correct responses across five different programs: generalized imitation, respond to name, incidental following directions, incidental auditory observing, and incidental visual observing. There were 20 opportunities for each of the five programs, making a total of 100 opportunities. Measures are presented from both pre- and post-probes. All three participants emitted accelerated learning of objectives and significant increases in observing responses after the completion of rotated protocol immersion.

Figure 4 shows the total number of intervals in which the students were engaged in non-functional self-talk across three settings: free, 1:1 instruction, and group. There were 60 5-second intervals measured in each setting, for a total of 180 possible intervals. Measures are presented from both pre- and post-probes. Figure 5 shows the total number of appropriate verbal interactions emitted during interval recordings across the three settings. Appropriate verbal interactions included mands, tacts, sequelics, and intraverbals. Measures are presented from both pre- and post-probes. And Figure 6 shows the total number of learn units required to meet criterion on regular instructional programs both before and after rotated protocol immersion.

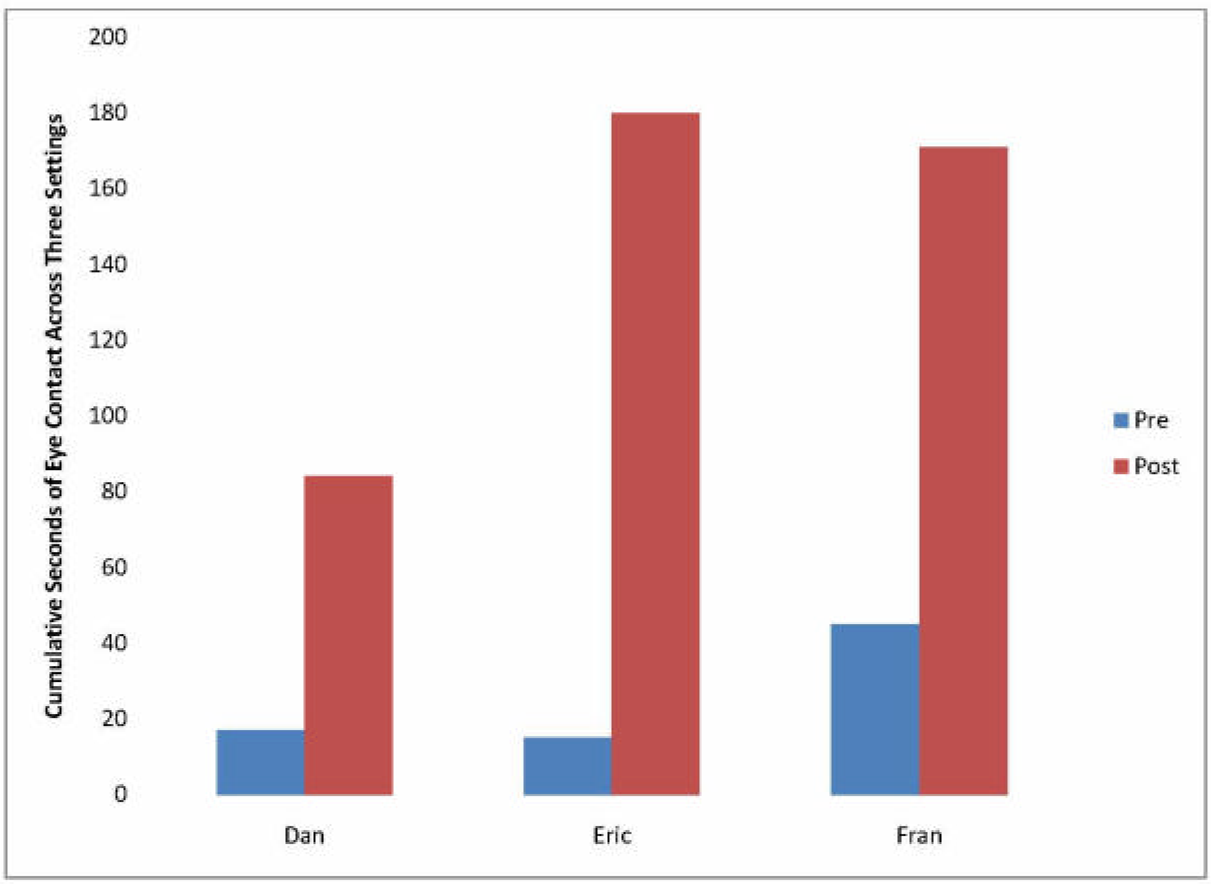

Figure 2. Cumulative Seconds of Eye Contact in Three Settings for Participants Before and After Rotated Protocol Immersion.

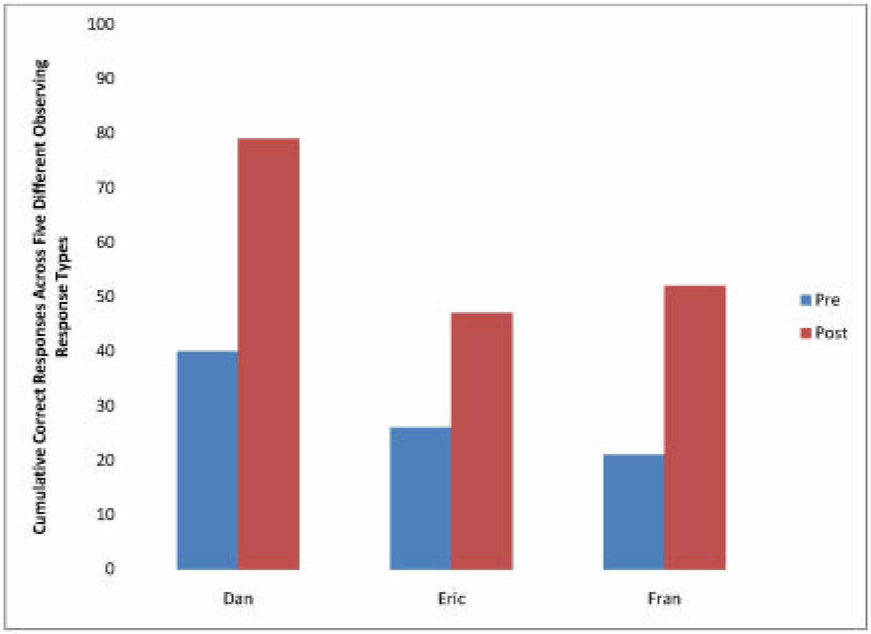

Figure 3. Cumulative Correct Responses Across Both Visual and Auditory Observing Responses For All Participants Before and After Rotated Protocol Immersion.

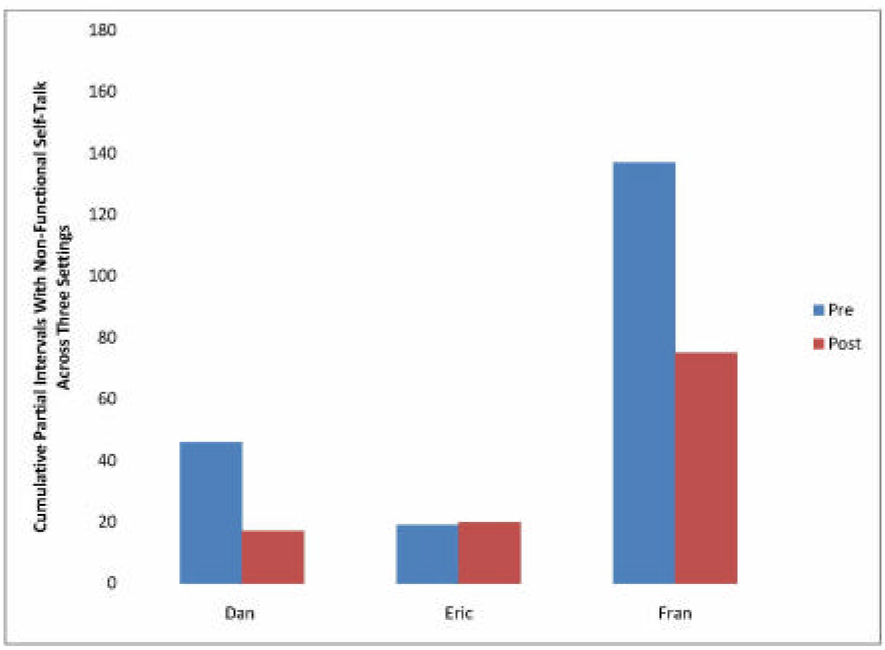

Figure 4. Cumulative Number of Partial Intervals Engaged in Non-Functional Self-Talk Across Three Settings For All Participants Before and After Rotated Protocol Immersion.

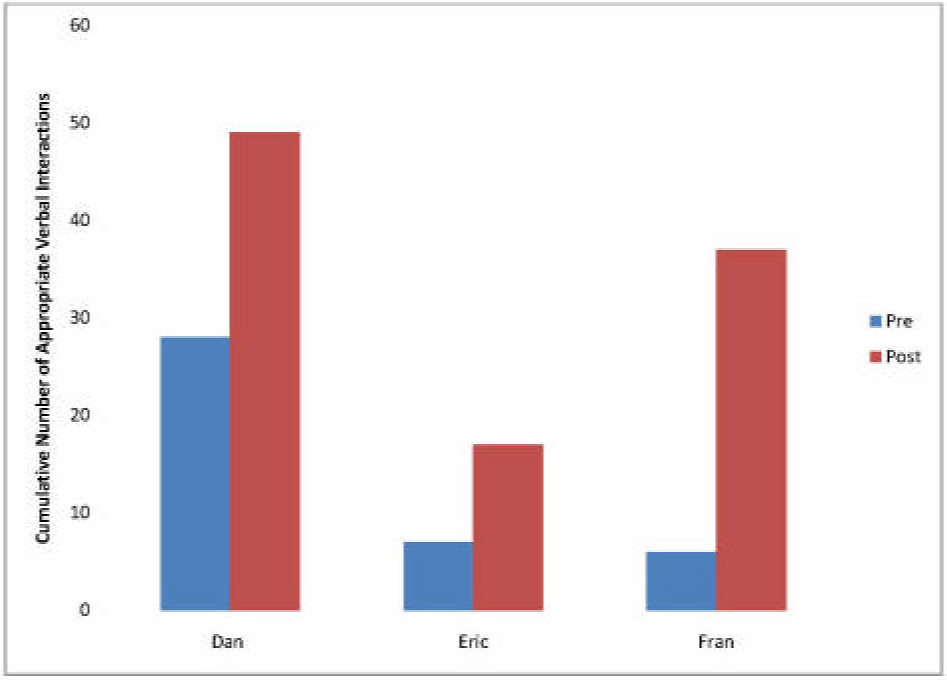

Figure 5. Cumulative Number of Appropriate Verbal Interactions Across Three Settings for All Participants Before and After Rotated Protocol Immersion.

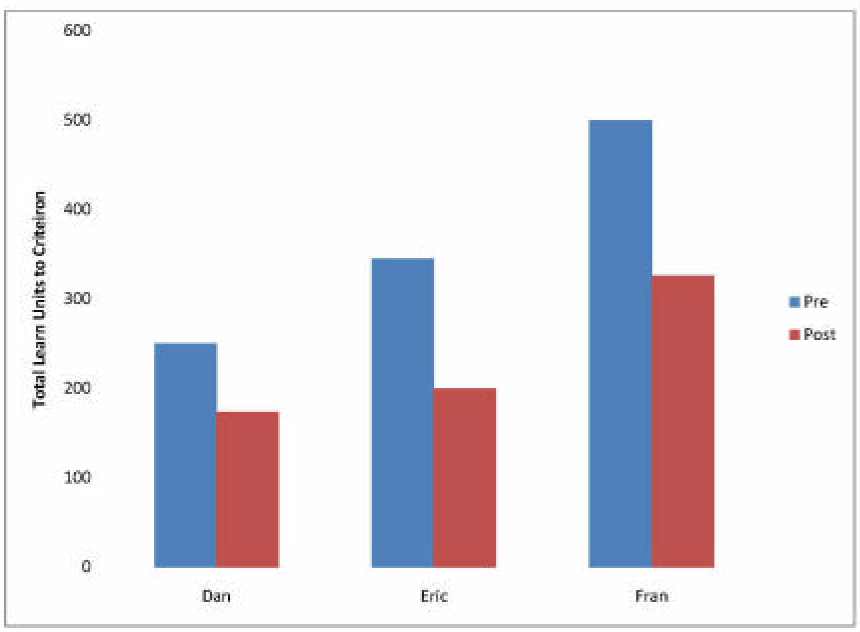

Figure 6. Total Number of Learn Units Required to Achieve Criterion in Regular Academic Instruction for All Participants Before and After Rotated Protocol Immersion.

A functional relationship was demonstrated between exposure to the rotated protocol immersion and the emergence of new verbal capabilities. Participants' data demonstrated changes in responding across a variety of areas of significance for each participant.

Discussion

The data for all three students showed significant changes in the dependent measures we examined. The results of this investigation indicated a functional relationship between the use of rotated protocol immersion and the emergence of generative behavior for these students. The increases in observing responses as reported are representative of the achievement of new verbal developmental capabilities for each student. Individual differences in pre- and post-probe performances are likely a function of the prerequisites and instructional histories of each of the students at the outset of the study.

Anecdotally, all students were observed by teachers, staff and parents to have made significant gains in terms of observing responses. These qualitative changes coincided with the students' participation in rotated protocol immersion. One student began to notice others, commenting on their belongings, running to the window to watch students filing past the classroom, commenting on the weather outside. This student even began to emit peer tutoring responses, completely untaught—reaching over to guide another student's finger to point to the right answer in a group instructional session. These were instances of truly social behavior, and represent the type of complex social interactions that we hoped our students would eventually achieve, but, had not observed before we implemented rotated protocol immersion. Another student began to notice objects, playing appropriately with toys in the play area that, before participation in rotated protocol immersion, he had simply ignored. Again, this behavior was completely novel and untaught and not observed before. Although these are simply anecdotal observations, they support the measured changes reported in the results section of this paper.

We submit that the changes we observed in our students post-rotated protocol immersion supports the theoretical concepts presented earlier. If foundational verbal developmental capabilities can be induced, there are great implications for the future of intervention and remediation of individuals with and without disabilities who do not have these essential foundations of language. There is still much to clarify and investigate. A combined theoretical and research based approach is essential and should provide a solid platform from which to build evidence for this effort.

Research in the areas of development, language, and observation are topics that are common across many sub disciplines of psychology and human sciences. Because of the commonality of our research goals it is important to synthesize the findings of different disciplines, find a common terminology with which to communicate, and subject our theories to the rigorous test of survival of the fittest. Bechtel believed that this was an essential feature of growth in the field of science. He proposed that inter-field theories would successfully integrate theory from several disciplines and create more robust theories than could ever be achieved by a single discipline (Bechtel, 1988).

Toward that end, our findings could be examined more closely through the lens of the developmental psychologist and, perhaps, that examination could suggest further directions for research in that area. From a conceptual perspective the term "sensitive period" appears to be similar to the term "behavioral developmental cusp." Bornstein refers to a sensitive period as one that "minimally implies that a certain experience at a certain time in the life cycle of a system may exert a dramatic effect on the future developmental course of that system (Bornstein, 1987)." Bornstein identifies sensitive periods as differing in specifics but common in general to all sub disciplines of psychology, making it worthy of efforts to reach common understandings about how they work. He outlined common structural and causal characteristics.

Structural characteristics were outlined by Bornstein, as follows: "A comprehensive statement about a sensitive period ought reasonably to include information about (1) how long it took to develop, (2) how sensitivity changed and whether the change was stable, (3) how long the sensitive period lasted, (4) how long it took to decay, (5) when and how often in the life cycle it occurred, (6) what was changed, (7) what process regulated the change, (8) what the effective stimulus was, (9) how that stimulus affected

whatever changed, (10) whether the change was unique, (11) individual and species variation in the change, and (12) how fixed the sensitive period is. Moreover, such a statement ought to indicate (1) what in later development showed a change, (2) what the change was, (3) when it occurred, (4) how long it lasted, and (5) how fixed it was." (Bornstein, 1987, p. 8-9). The results of the research we've presented in this paper suggest answers to some of these questions.

Bornstein related causal characteristics of sensitive periods in two ways: ultimate causes (why do sensitive periods arise in the first place?) and proximate causes (how, specifically, are they instigated?). His conception of sensitive periods make a contribution to our understanding of the phenomena we have investigated, and give us additional ways to talk about our observations and findings. They also suggest further directions for research in this area. We submit that our research suggests one answer to the question of proximate cause and we hope that further research in this area might lead to additional answers to proximate cause or to answers of ultimate cause. For our students, the change in their verbal developmental capabilities means that they now can learn things that they could not learn before. We are challenged by this change to find better ways of teaching the new learner who has emerged.

Our research has followed the responses of our students. We have formed theories of language development in children based on our research, and a result of that research, our analysis of the evolution of language and its interaction with the environment, has formed the basis for practice (Greer & Keohane, 2005). We have formulated these theories with practical, functional purpose and investigated these phenomena in order to operationally define them so that the information we find can be used for practical purposes (Greer & Ross, 2008). We believe our contribution represents a piece of the puzzle as it relates to the foundations of language for children (Keohane, Pereira Delgado & Greer, in press), and we continue to explore new ways to address the many questions that remain unanswered. We understand that each answer will lead us to new questions, and expect that analysis of the data for each of our students will lead to more comprehensive answers. We hope our continuing efforts will contribute to the research base on the evolution of verbal behavior (Greer & Keohane, 2005; Greer & Ross, 2008) as we join with others (Catania, 1998; Hayes, Barnes-Holmes & Roche, 2001) in an effort to answer each new question.

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